# R-θ Fiber Positioner for the BigBOSS Instrument

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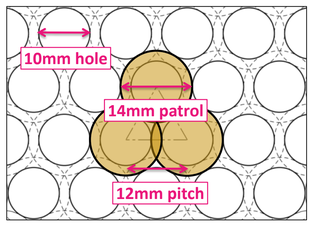
## INTRODUCTION

The BigBOSS instrument is a proposed fiber-fed spectrograph for the Mayall 4 m telescope at Kitt Peak, Arizona, which will measure the redshift of 20 million galaxies and map the expansion history of the universe over the past 8 billion years, surveying 10-20 times the volume of existing studies.

The focal plate of the new telescope's prime focus optics will be populated with 5,000 robotic fiber positioners, each targeting and tracking an individual galaxy with every exposure.

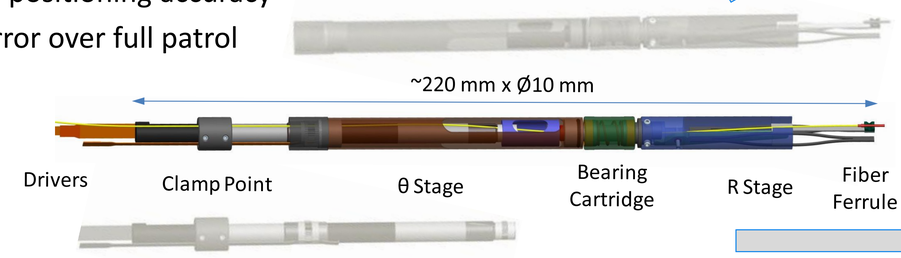



**ENVELOPE:**

12 mm center-to-center pitch
14 mm overlapping patrol zones

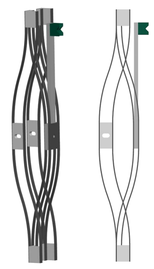
**KEY PERFORMANCE TARGETS:**

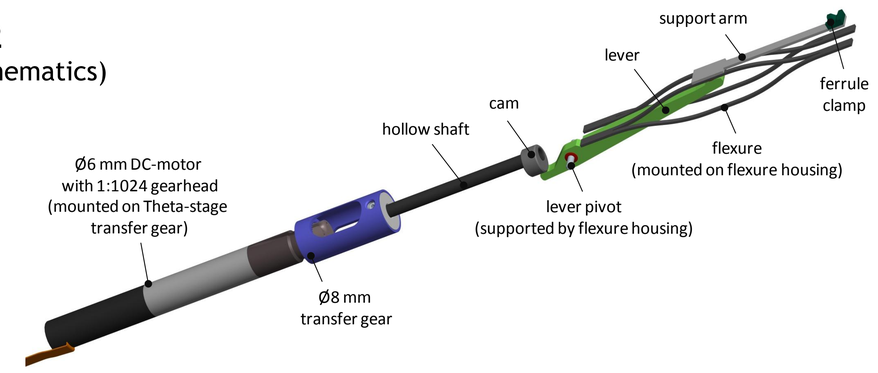
<5 µm positioning precision
<40 µm open-loop positioning accuracy
<20 µm defocus error over full patrol
<0.15° tilt error



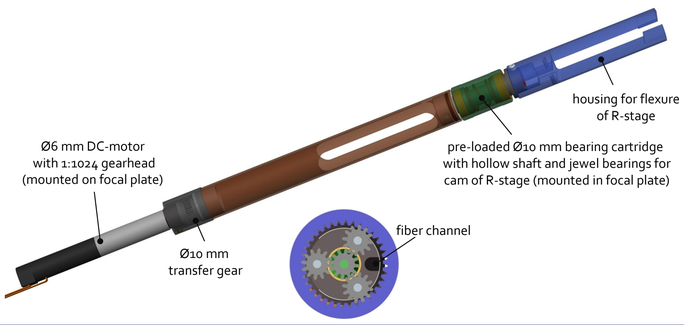

## R-Stage

Key component: **Flexure**
(controls radial motion kinematics)

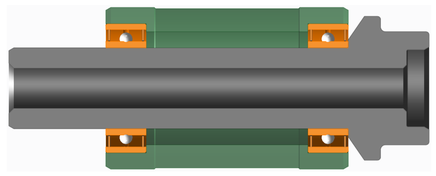





## θ-Stage

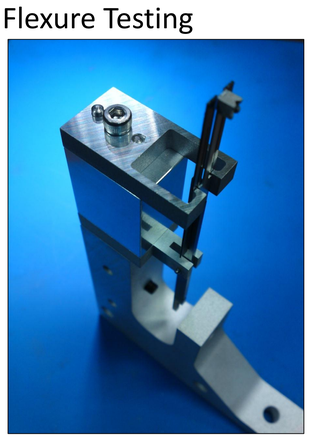


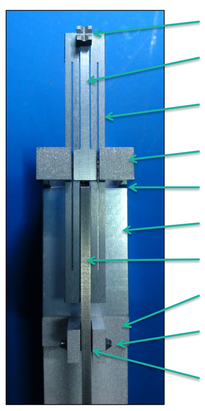

Key component: **Bearing Cartridge**
(mechanical interface / tilt control / smoothness of rotation)

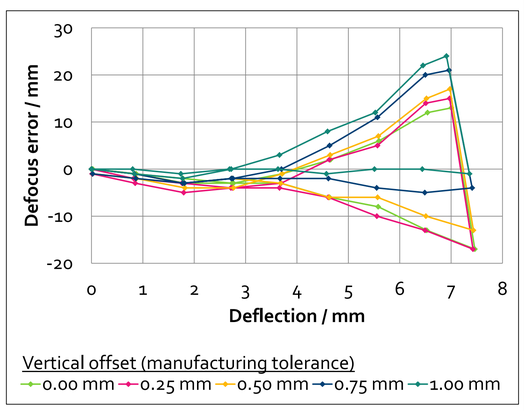


## SUBCOMPONENT TESTING

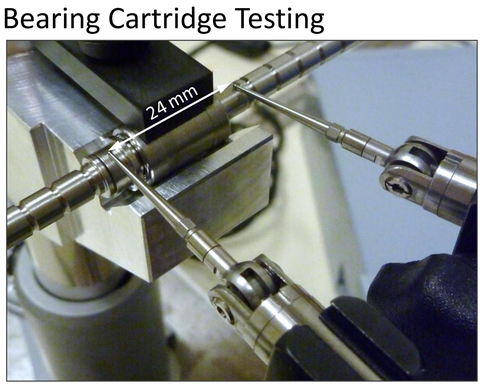
### Flexure Testing

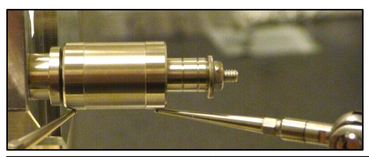


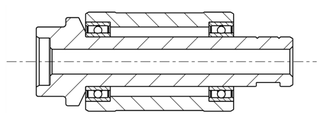



### Bearing Cartridge Testing

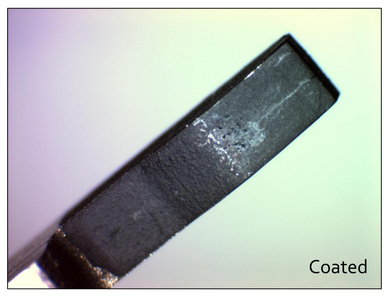


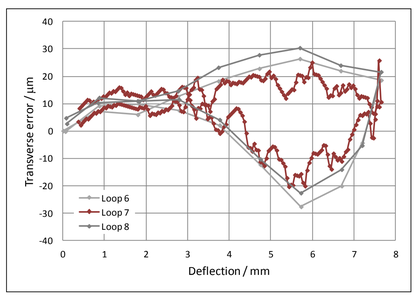


| | Min | Max | Average | Unit | Notes |
|---|---|---|---|---|---|
| Axial Displacement | 0.0 | 1.0 | **0.4±0.2** | µm | 0.5…3.5 N axial load |
| Tilt of nominal shaft axis | 0.007 | 0.032 | **0.019±0.007** | deg | roundness of sleeve included |
| Tilt due to radial run-out of shaft | 0.006 | 0.018 | **0.013±0.004** | deg | roundness of shaft included |
| Torque resistance | 4.6E-05 | 5.8E-05 | **5.0E-05±0.8E-05** | deg/Nmm | 40…120 Nmm load |
| Radial stiffness | | | **>8** | N/µm | -4…+4 N radial load |
| Axial stiffness | measurements ongoing | | | | |

### Lever Fulcrum / Friction

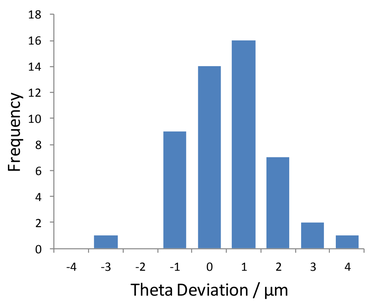




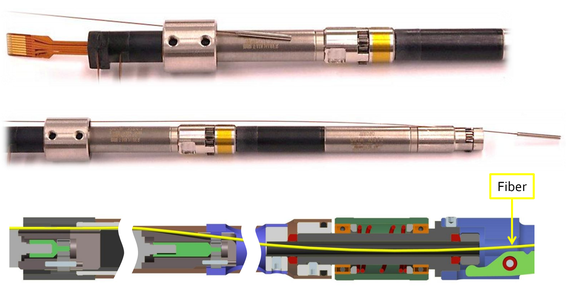




### Geartrain+Bearing Repeatability




### Fiber Transfer / Safe Passage

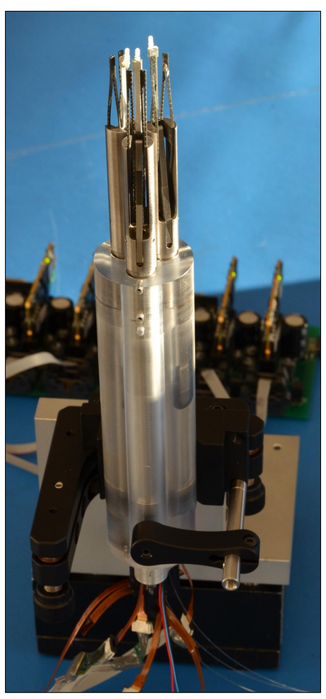



## FULL POSITIONER TESTING

Testing of full positioner is currently underway, with 5 test articles. Test plan has 4 major categories:

1) Positioning precision and absolute accuracy
2) Positioning speed
3) Power consumption
4) Axial tilt

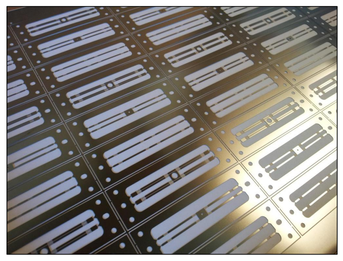
Below, a series of images of the prototypes are shown, to illustrate the mechanisms and manufacturing technique.




Core of front module


Cams with hollow shaft

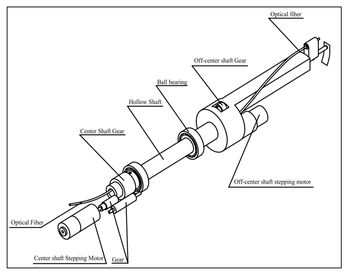

Housing with single-blade flexure

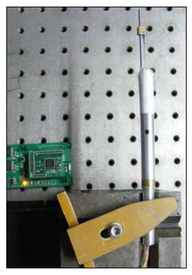



## COLLABORATOR DESIGNS AT USTC AND IAA

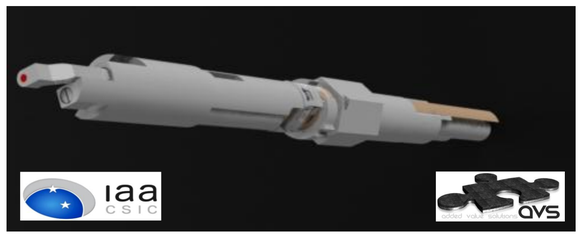
BigBOSS has several concurrent R&D efforts building fiber positioner prototypes. This poster has mainly described the R-θ effort at LBNL. However, promising θ-θ designs are currently also being built and tested within the collaboration at USTC and at IAA.

### University of Science and Technology of China (USTC)



### Instituto de Astrofísica de Andalucía (IAA)

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